Analyses of Solid Earth Tides and Their Residuals for GPS Time Series Data Obtained from Kinematic PPP Method

Tadahiro Sato[1]; Yusaku Ohta[2]; Kouta Takatsuka[2]; Satoshi Miura[2]

[1] AOB; [2] RCPEV, Graduate School of Sci., Tohoku Univ.

Different from conventional relative positioning methods for GPS data, precise point positioning (PPP) methods have an advantage that we can obtain time series of coordinates at individual GPS stations without using a reference site. In addition, the PPP solutions can be derived even for epoch by epoch by a new GPS analysis software, for example, GpsTools (Takasu et al., 2005) to reveal high frequency coordinate changes at each GPS site (hereafter, we call this method as Kinematic PPP, or K-PPP). Therefore, this method can be applied to study such high frequency phenomena as earth tide, tsunami and seismic waves. However, different from the relative positioning, the K-PPP method has a week point that a compensation of common errors does not work well. As a study to improve the positioning error in the K-PPP method, we have computed a time series by using the K-PPP method as the tidal componets are unknown parameters to be solved, and we analyzed the earth tides and examined the time series of the tidal residuals.

Here, we analyzed the GPS data obtained at 5 GEONET sites located along a line extending from Japan Sea side to Pacific Ocean side in the Tohoku region. In this study, we used GpsTools ver.0.6.3 (Takasu et al., 2005) to obtain K-PPP solutions including tidal signals, BATRAP-G (Tamura et al., 1991) to extract tidal constituents, and GOTIC2 (Matsumoto et al., 2001) to predict theoretical earth tides for comparison with observed tides. We have tested two values for the constraints of random-walk process noise, 0.5 and 0.05 m/sqrt(sec), which were assumed in the K-PPP analyses. In GOTIC2, a model by Wahr (1991) is used to compute the theoretical solid tide. We have also compared another tidal model by Dehant et al. (1999, hereafter DDW model), which are now frequently used to estimate the tidal effect in the nutation. Finally, we studied the characteristics of the spectrum at each GPS site, by using the residual time series as the sum of the trend and irregular components obtained from the BAYTAP-G analysis.

Tidal analysis results indicate; (1) the estimated tidal amplitudes and phases are not so sensitive to the difference in the magnitude of the constraints on random-walk process noise, (2) the estimated tidal amplitudes for the M1 and O1 constituents, which are considered not to be heavily affected by errors in the troposperic corrections, show intermediate values between those predicted by the DDW hydrostatic model and the DDW non-hydrostatic/inelastic model.

On the other hand, the frequency characteristics of the residual spectrum are different from the site to site. We examine the relationship between the characteristics of spectrum and the geographical characteristics of each site.